



## THE SYSTEM FOR SIMULATING INTERBANK SETTLEMENTS

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**Abstract.** The aim of this paper is a study of the system for simulating interbank settlements. Interbank payment and settlement systems establish conditions for the circulation of financial funds on the market and guarantee the distribution of assets. Practical experiments in an active system are very risky. They demand to simulate their operation through a system by creating its mathematical model. By perfecting the processing of settlements and/or developing algorithms for solving the gridlocks or by applying the tools of refinancing and using reserves of requirements, one can change the efficiency of settlement systems. The results of the study by Monte-Carlo simulation are given, based on data of the payment and settlement system of the Bank of Lithuania.

**Keywords:** interbank payments, settlements, payments flow, modelling of interbank payments.

### 1. Introduction

When introducing electronic technologies in the area of financial services, it is necessary to solve the tasks of processing and managing settlement flows in order to minimise the costs of settlements and liquidity, credit and systemic risks. The main purpose of such systems is to warrant a fast and rational turnover of settlements, to balance payments, and to reduce the movement of money supply. These systems should provide the principles of stability, efficiency, and security. Participants of the system must meet the requirements of liquidity and capital adequacy measures. The owner, operator, and supervisor of such a system by default is the central bank. It installs a request for the participants of the system, conducts supervision over their performance and takes measures to guarantee a stable system operation.

The target of this paper is interbank settlement systems and their topology, the systems of settlement modelling and simulation, performing the simulation of settlement process as well as the calculation of settlement risks and settlement cost. The results of the system study by

Monte-Carlo simulation are based on the data of the payment and settlement system of the Bank of Lithuania.

Over the past few decades, the settlement has increased significantly. Using the information technologies (IT), the market of financial services has been developing very fast. The development of interbank settlement systems has demanded theoretical and experimental research in this area. Due to a high sensitivity and possible effects on the economic and social environment, the systems of payment are in fact not the subject to experiment changing parameters in the real environment. Practical experiments in an active system are very risky. For modelling their operation through a system they demand creating its mathematical model. The Bank of Finland [1], the Bank of France [2], the Bank of Austria [3] and the Bank of England intensively work in this area.

The objective of the article is to investigate and survey the system of interbank payments and settlements and analyse the possibility of simulating the interbank payments system. The results of study by Monte-Carlo simulation are given, based on the data of the payment and settlement system of the Bank of Lithuania.

## 2. The structure of the interbank settlements system

Transactions of settlements consist of the procedures of account debit and credit. The assets move from one correspondent account to another and book to a final receiver's account. Similar procedures are executed in the security systems with the function of payment and settlement systems [4]. In the security settlement systems, the security account of senders is debited by the face value of securities are debiting and the receiver's account is crediting by the same value [5].

The participants of a settlement system apprehend the system as the flow of sending and receiving transactions, which is booked in the settlements balance of participants [6]. Some participants of the system experience the influence of sent transactions, while others suffer the influence of received transactions. Therefore two flows of settlements and their influence on the participants of the system are distributed [7]. These flows change the balance of settlements.

The purpose of settlement systems is to guarantee effective settlement process. The process within a settlement system is divided into such phases [8]:

- submission phase;
- entry phase;
- booking phase;
- queueing phase;
- gridlock identification and resolution phase;
- queue allocation phase;
- end of the settlement phase.

In the submission phase, the participants send a transaction to the system for processing. In this phase, the internal transaction queue is formed as well as the participants of the system are ordered in the transaction priority. The real data of one application of the payment and settlement system  $y = (ID, a, b, t, p, e)$  consist of:

- the number of application  $ID$ ;
- the name or code of the participant  $a$ , which sends applications;
- the name or code of participant  $b$ , which receives applications;
- time and date  $t$  of submission of an application;
- volume of an application  $p$ ;
- additional information  $e$ .

Additional information is assigned to the receiver of transaction. Using this information, the account of participant to receiver is credited.

In the entry phase, the settlement instructions received by senders are estimated and the processing methods of transactions are chosen. In this phase, the possibilities of transactions performed are analysed as well as that of splitting and queueing them are analysed. The transaction sender is informed about the status of transactions and settlement opportunities.

During the entry phase the booking in a participant's account is executed. In this phase, the account of a transaction sender is debited and the account of a transaction receiver is credited.

In the queueing phase, unfulfilled transactions are queued. In this phase, the settlement instructions on the entry phase (ie splitting, transaction priority instructions) are used.

In the gridlock identification and resolution phase, using simulation of the execution queue of transactions, the best scenarios of solving the task of the transaction queue are applied. In this phase, the gridlocks of transactions are identified, if a transaction cannot be carried out due to the temporary illiquidity of the participant in the settlement system. The temporary illiquidity of the participant in the settlement system can be solved by reconstructing the transaction queue and settlement processing. The definition of a gridlock is described in the Chapter 5.

The processing scheme of the payments and settlement system is presented in Fig 1.

In the queue allocation phase, the queued transactions are realised as soon as they become eligible for booking.

In the phase of settlement end the day balances of participants are made up and the final list of unfulfilled transactions created.

The structures of payment processing and the security settlement system can be analysed according to the complexity of these systems. The main elements of submission, entry, and booking phases are available in all the systems. The queueing and queue allocation phases depend on the availability of queueing scenarios and allocation modes. The Payment and Settlement systems consist of the system operator and participants (banks, unions of credit, and other institutions of finance and credit) [9]. These systems can be analysed as hierarchical suites of interacting participants, which pursue their own policy with different criteria on the basis of the wholesome function. The major distinction between the different interbank payment systems is whether a system is operating on a net or gross basis, or payments are processed individually in the batches [10]. The most common 3 pure implementations of these principles are: real-time gross settlement (RTGS), time-designated net settlement (TDNS), and continuous or secured net settlement (CNS). By perfecting the processing of settlements and/or developing algorithms for solving gridlocks, or by applying the tools of refinancing and using reserves of requirements one can change the efficiency of settlement systems [11]. In the TDNS, settlements are made in the set intervals of time. In the real-time systems, settlements are made continuously. Interbank settlement transfers in RTGS systems are directly booked on the central bank accounts: ie payments and settlements are processed simultaneously [12]. In CNS systems, payments are booked immediately, while the final settlement, eg with the central bank money, is typically delayed until the day end. By perfecting the process-

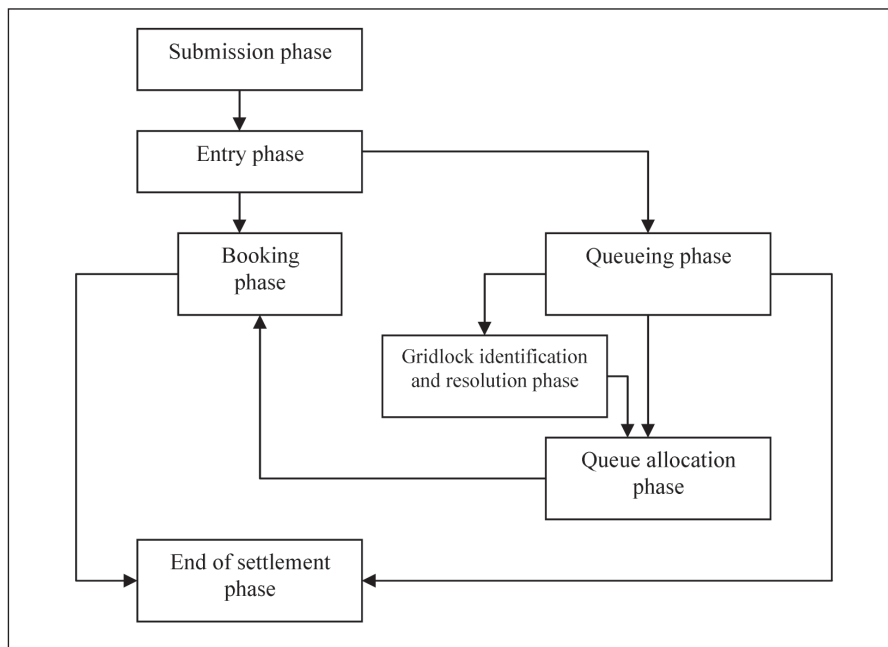


Fig 1. The processing scheme of payments and settlement system

ing of settlements and/or developing algorithms for solving gridlocks, or by applying the tools of refinancing and using reserves of requirements, one can change the efficiency of settlement systems [13].

### 3. A centralised, decentralised, and hybrid system of settlement

The settlement systems are classified according to the structure and functions and have a different architecture. Most often the centralised star form and symmetrical systems are found [4]. The star-like form settlement system consists of the central institution of settlement (automated clearing house – ACH) and the participants of the system. Each participant of such a system sends a transaction to ACH and receives the transaction of other participants from ACH. In ACH the gross balances of settlement accounts of participants are calculated and the service of correspondents account is provided [14]. The architecture of the centralised settlement system is in Fig 2.

In the completely symmetrical systems of settlement all transactions are fulfilled individually. Each participant of the system keeps in touch with another participant’s personality and calculates its own settlement balances [15]. The architecture of the completely symmetrical settlement system is presented in Fig 3.

The system risk is concentrated in one point of the centralised settlement systems because in this case the confusion in ACH destroys the settlements of all participants.

In case of the completely symmetrical settlement system, the execution of bilateral settlements is more effective, since the settlement processes management can be

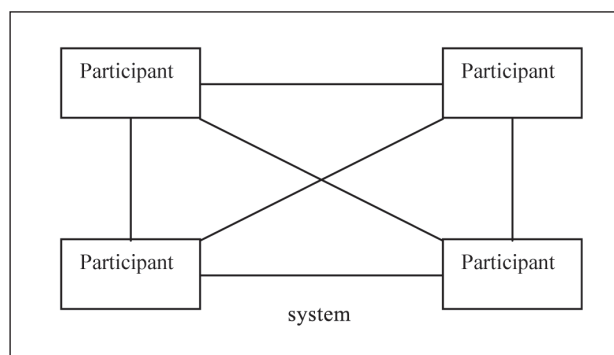


Fig 2. The centralised architecture of the settlement

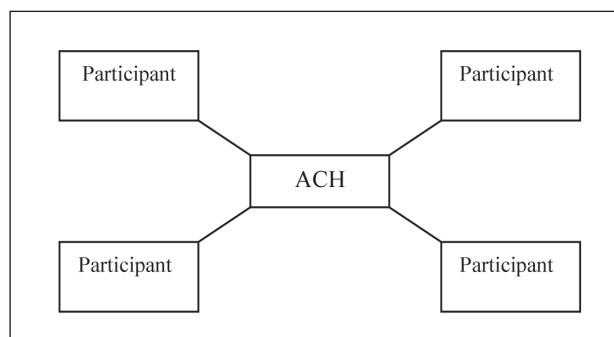


Fig 3. The architecture of full symmetrical settlement system

performed individually. The latter architecture decreases the general settlement risk. Disorder of one participant in such a system does not have a direct effect on the settlements of other participants [16]. In this case, other participants have a possibility to execute bilateral settlements. An imperfection of the architecture of the completely symmetri-

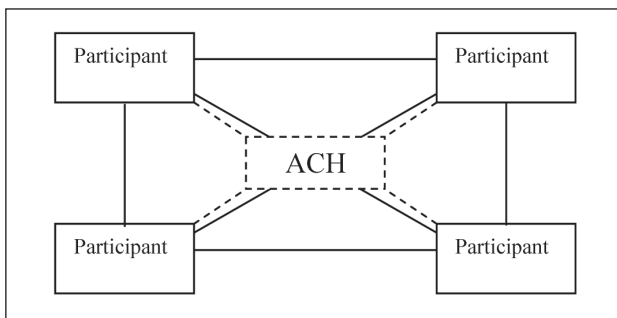


Fig 4. Hybrid architecture of the settlement system

cal settlement system is the large number of bilateral relationships. The effective management of such relationships complicates the work of participants because each participant fulfills the functions of ACH personally [17]. In case of the completely symmetric settlement system, compatibility of participants in the internal system is problematic.

The contemporary systems of settlement allow us to make the mentioned architectures compatible and let choose better characteristics of such a system by using hybrid settlement systems [18]. The main transactions of such a system are executed by a symmetry principle, while the management of such a system is centralised. The hybrid architecture of a settlement system is presented in Fig 4.

In the hybrid systems the processes of risk are controlled and the security measures of management are taken by ACH. In the real-time environment ACH generally updates only counterpart settlement balances. In this case, the process of settlement does not require for the ACH to sort batches of transactions by participants.

#### 4. The flow of transactions and its management

The flow of transactions influences the requirement of liquidity and the position of credit [19]. The main purpose of a more modern settlement system is a decrease of general risk in the system and an increase of settlement speed [20]. To achieve this aim the procedures of reorganisation of transaction flow are performed. The need of liquidity is different in each settlement system [21]. The CNS system without settlement delay requires more liquidity in

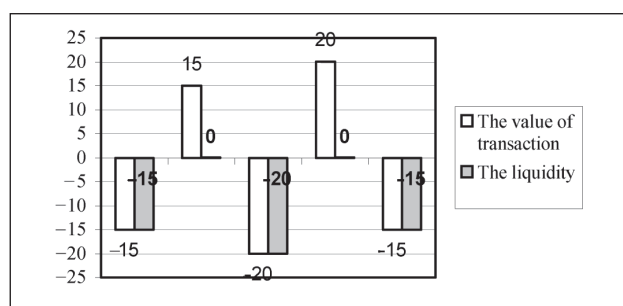


Fig 5. The example of transactions flow, when the liquidity position of a participant is deficit or zero

comparison with the DTNS system, because in the CNS system the transaction flows continuously and the assets to make a settlement are necessarily continual, while in a DTNS system a bilateral flow of transactions is concerted and settlements are processed in a set time by a bilateral netting process. Therefore in the CNS system, a possibility to satisfy the liquidity by reorganising the transaction queue without settlement delay is lost [22]. In the systems with settlement delay the participants of the system are able to eliminate out transaction flows [23]. Figs 5–7 give examples of the impact of transaction flows on the liquidity needs of participants during the settlement period.

Fig 5 shows that the participant continuously has a deficit or zero position towards the other participants. In this case using short-term loan instruments the liquidity can be ensured. Otherwise, the obligations of participants will be not fulfilled.

In the case shown in Fig 6, the participant has its intraday position positive or at least zero for most of the day.

In this case, the participant can satisfy its obligations during the whole settlement period except for the last transaction. To fulfill the last transaction, the participant needs short-term loans.

The example in Fig 7 shows that the participant continuously has a deficit position towards the other participants and all transactions are delayed to the day end.

All 3 examples have the same transaction flow, with the same results at the end of a day balance. But the influence of flows on the liquidity of participants during the whole settlement process is different.

On the settlement market the cost of short-term loan instruments is defined, therefore the main purpose of the participants of the settlement system is to adjust the transaction flow so as to minimise the cost of liquidity and to satisfy all obligations [24]. The high cost of short-term loan instruments compels the participants to avoid a deficit of liquidity at the end of a day balance and put up with the deficit of liquidity during the settlement period [25].

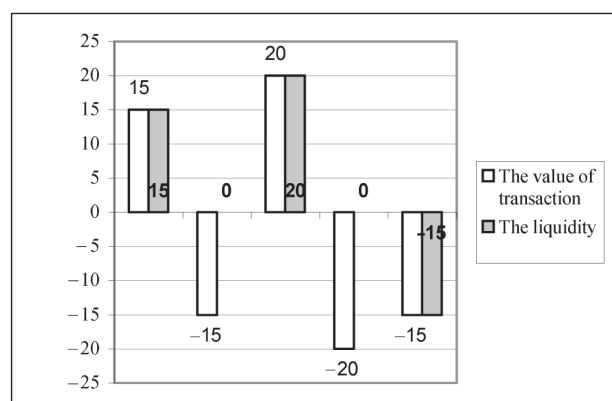


Fig 6. The example of transaction flow, when the liquidity position of a participant is deficit only at the settlement period end

The structure of transaction flow influences the position of liquidity and the size of credit risk in the settlement system of participants. Therefore in the settlement systems the procedures of monitoring and control of transaction flow are executed [26].

The first step to control the transaction flow is an external system of participants in transaction submission [22]. In this step, the ACH makes a decision, when the submitted transactions of participants can be fulfilled. The central settlement system of ACH has a subsystem of primary submission of transactions. To this subsystem the external system of participants sends the transaction flow. The ACH sends transactions received from the primary submission subsystem to the central settlement system following additional information, which is presented by the participants (the additional information may have the time of transaction processing).

Most often the processing of transaction flow is executed by using the elementary method of FIFO means (first in, first out) [23]. Since the transactions in the flow are of different priority and fulfilling speed, the instructions define not necessarily the attendance in order FIFO. Also, another transaction flow may be used to queueing methods. The transactions may be performed in view of the transaction value to fulfill small value transactions. In such systems the participant is able to respect transaction queue with respect to the priority of transactions.

Splitting of transactions establishes conditions for the most effective usage of liquidity. The process of transaction splitting can apply two main scenarios: establishment of the largest value of transactions and the use of full liquidity [23]. In the first case, the largest transaction will be split. In the second case, the largest part of a transaction to be performed is determined.

By ordering the transaction queue in the settlement system we can cause the increase of accumulation of transactions. The participant of the system may delay the transaction by decreasing the need of liquidity [27]. The transactions can be postponed to the settlement period end. If most of the participants will concentrate the transactions to the settlement period end, accumulation of transactions can be caused at the settlement period end.

### 5. Gridlocks and deadlocks and their solving methods

A gridlock is a situation in which the failure of one of the banks to execute transfers prevents a great number of other participants' transfers from being executed [28]. The solution of gridlock situations uses several algorithms: splitting of transaction, bilateral reorganisation of bilateral transactions, full and partial net procedures.

The transaction splitting method has been mentioned as the method for controlling the transactions flow, but it may be used in the solution of gridlock situations, too. Let two bilateral transactions be presented when one of the par-

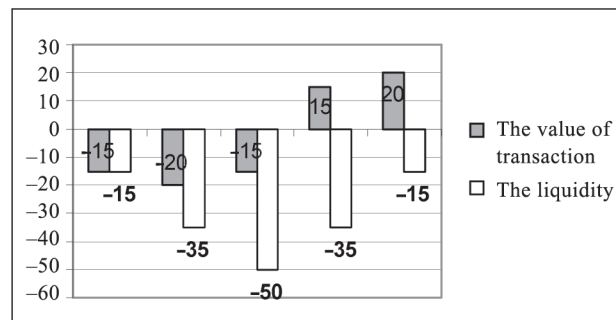


Fig 7. The example of transactions flow, when the liquidity position of a participant is deficit in the whole settlement period

ticipants has the necessary liquidity to fulfill the transaction. In this case, the splitting of transactions into available liquidity may be done by realising a part of obligation. The increase of liquidity may render the possibilities to pursue other transactions and solve the existing problem of gridlock. An alternative method for solving the gridlock is reorganisation of bilateral transactions. The reorganisation of transactions may be executed by setting the transaction priorities, adjusting the transaction volume in FIFO.

Completely multilateral netting method is the most common method for solving the gridlock. The principles of effect are booking of the gross transactions balance on the settlement account [29]. In the case with insufficient liquidity, the method of partial multilateral netting is applied. By applying the partial multilateral netting method, some transactions of a participant are removed from the transaction queue. In this case, the realisable transactions are held in the queue. The transaction is temporarily removed from the queue until the participant will acquire the necessary liquidity.

The methods of solving the gridlock depend on the available liquidity of a participant and the urgency of transactions. If the participants of the system have sufficient liquidity, the queue of waiting transactions is short or missing [30]. In this case, the gridlock rarely occurs and the need for its solution is minimal. The usage of netting always requires to make up a queue of waiting transactions and to accumulate the sum of transaction to realise a settlement. If all the transactions are urgent and cannot wait in a queue, the participant has no alternatives to delay the transactions and must ensure the necessary liquidity to fulfill transactions without delay.

The example in Fig 8 shows the gridlock situation. In this case, all the participants have the lack of liquidity to fulfill the transactions. Only the splitting of transactions and a partial settlement of one of the participants can solve the given situation. One of the solutions in this situation is presented in Fig 9. In this case, the gridlock can be solved when participant B1 fulfills a partial transaction, the value of which is 10,00 conditional units.

In the settlement process, a situation is possible where

the reorganisation of a queue has been made, and the gridlock cannot be solved (Fig 10). Such a situation is called a deadlock. The example in Fig 10 shows that the gridlock cannot be solved even if a queue has been rearranged.

The deadlock situation can be solved only using short-term loans.

## 6. Statistical simulation of settlements costs

We calculate the average costs of service and evaluate the probability of losses of liquidity by simulating a few periods of settlements.

Denote the cost of transactions during one period by

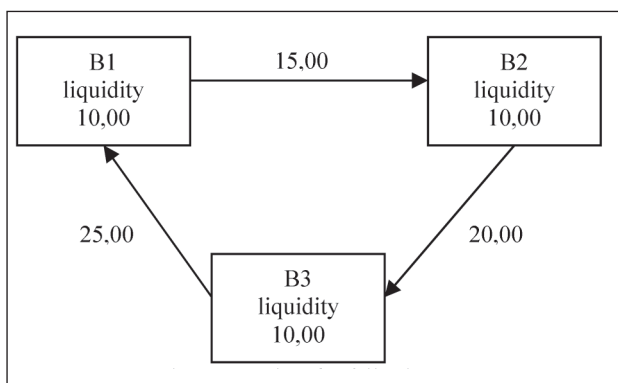


Fig 8. The example of gridlock

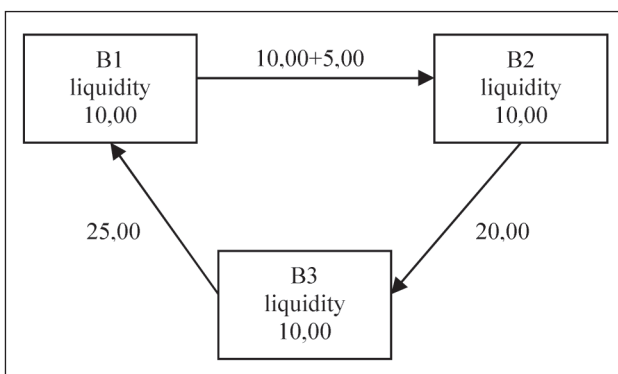


Fig 9. The example of gridlock solution

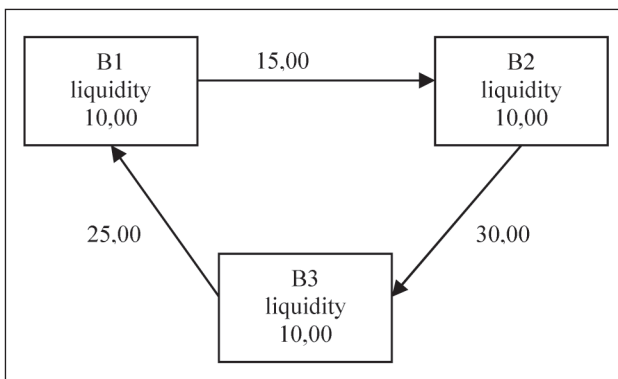


Fig 10. The example of deadlock solution

$D_i = D_i(X_i, \delta_i)$ , which is a random function in general, depending on the deposit  $X_i$  and the vector of balances of the correspondent account  $\delta_i = (\delta_i^1, \delta_i^2, \dots, \delta_i^T)$ , here

$$\delta_i = \sum_{l=1}^T \delta_i^l, \quad 1 \leq i \leq J.$$

Denote the expected cost during one period by

$$L_i(X_i) = ED_i(X_i, \delta_i). \quad (1)$$

In order to estimate the influence of the parameter  $X_i$  on the cost, it is necessary to find a derivative of the cost function on the parameter  $X_i$ . Note, that the function  $D_i(X_i, \delta_i)$  is a piecewise differentiable function in general. Therefore we introduce a generalised gradient of this function, using expressions for computing subgradients [31, 32].

The payment and settlement system is characterised by operational, credit, and liquidity risk. For simplicity, we assume that all applications of payments are executed without adjournment. A successful performance of the payment system is guaranteed by keeping sufficient sums in the corresponding accounts. Insufficient sums of the clearing accounts cannot satisfy the credit obligations, because this fact destabilises interbank payments and sets gridlocks in the payment and settlement system. The Central bank allows borrowing overnight loans and installs reserve requirements to the settlement system participants in order to prevent the illiquidity in the payment system. Therefore the Central bank establishes reserve requirements  $RR_i$  for the participants of the settlement system. The reserve requirements depend on liabilities of a participant.

In order to study the policies of credit and liquidity risk control, we consider a probability of exceeding the correspondent account and operational costs of settlements.

The total cost of settlements of the  $i^{\text{th}}$  agent during one period consists of several parts:

$$D_i = RE_i + F_i + B_i + TT_i + AC_i, \quad (2)$$

where  $RE_i$  – the premium for deposit,  $F_i$  – the pay of non-conformity of reserve requirements,  $B_i$  – the cost of short-term loans,  $TT_i$  – the indirect bank losses due to the freeze of the deposited amount of assets (or possible profit of withdrawal) in the correspondent account, and  $AC_i$  – the operation cost.

Let us analyse how banks can manage settlement costs by depositing (or withdrawing) assets on the correspondent account. We consider the policy when banks deposit or withdraw certain fixed sums  $X_i^l$ . When computing operational costs, one has to take in account that a bank cannot withdraw more than the sum, present in the correspondent account. Thus after simple considerations the deposit or withdrawal are computed as follows:

$$G_i^l = \max \left( X_i^l, -\max \left( K_i^{l-1} + \delta_i^{l-1}, 0 \right) \right). \quad (3)$$

The system loses the liquidity if the sum of a part of the correspondent account of some agents is negative and the agent needs to use some tools for recovery of the liquidity:

$$K_i^{l-1} + \delta_i^l + G_i^l < 0. \quad (4)$$

The frequency of liquidity loss is computed as follows:

$$P_{likv} = \frac{\sum_{l=1}^T \sum_{i=1}^J H \left( \min \left( 0, K_i^{l-1} + \delta_i^l + G_i^l \right) \right)}{T}, \quad (5)$$

where  $H(\cdot)$  is the Heaviside function,  $K_i^l$  – the correspondent account residue of the bank  $i$  for day  $l$ ,  $\delta_i^l$  – the balance of the settlement day  $l$ ,  $G_i^l$  – the deposited or withdrawn the bank sum  $i$ . The calculation of parts of the total settlement cost is described in [31, 32]. The calculation of the settlement balance is described by Shafransky and Doutkin [33].

The payment and settlement system is characterised by a probability of losses of liquidity  $P_{likv}$  given in (5) and the total settlement costs:

$$D = \sum_{i=1}^J D_i. \quad (6)$$

Denote the cost of transactions during one period by  $D_i = D_i(X_i, \delta_i)$ , which is a random function, in general, depending on the deposit  $X_i$  and the vector of balances of the correspondent account by  $\delta_i = (\delta_i^1, \delta_i^2, \dots, \delta_i^T)$ .

Denote the expected cost during one period as

$$L_i(X_i) = ED_i(X_i, \delta_i). \quad (7)$$

The system is efficient if the general cost is lower. In the presented model, the agent is acting independently and its objective function depends only on the parameter  $X_i$ . Therefore to characterise the efficiency of the whole sys-

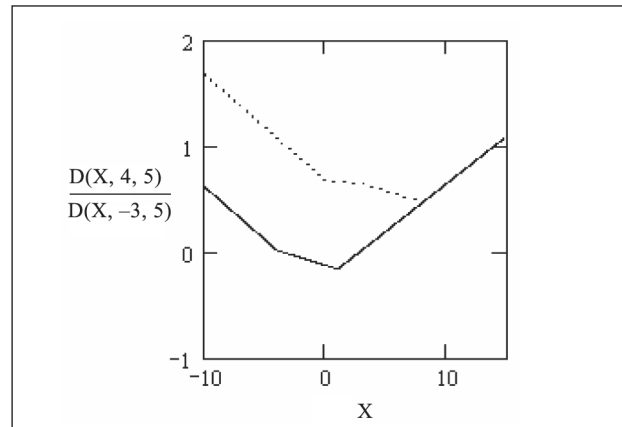


Fig 11. Dependence of the costs of settlements on the sum of deposit and day balance

tem, we can use the objective function (7) equal to the sum of the average costs of settlements. The objective function, from the viewpoint of a participant of the settlement system, is minimised by selecting the volume of deposit  $X_i$  under the fixed reserve requirements:

$$L(X) \rightarrow \min_{X \geq 0}, \quad (8)$$

where  $L(X) = \sum_{i=1}^J L_i(X_i)$ .

**Example.** Let us analyse an example that illustrates, how deposits and reserve requirements are chosen. For simplicity, we assume that the settlement period is one day and the day balance is distributed by Gaussian law with the parameters  $\mu = 0,5$  and  $\sigma = 0,5$  (in standard units). Let us take LBR = 5 %, IBR = 9 %, STL = 10 %.

In Fig 11, the dependence of the costs of settlements on the deposited amount  $X$  with an adequate day balance  $\delta$  and fixed reserve requirements  $RR$  is illustrated.

The dependence shows that the function of current costs is periodically linear. The function has a minimal point according to the interest rate. The function of average costs  $L(X, RR)$  and the gradient of the function  $Q(X, RR)$  can be calculated analytically in this example (Fig 12).

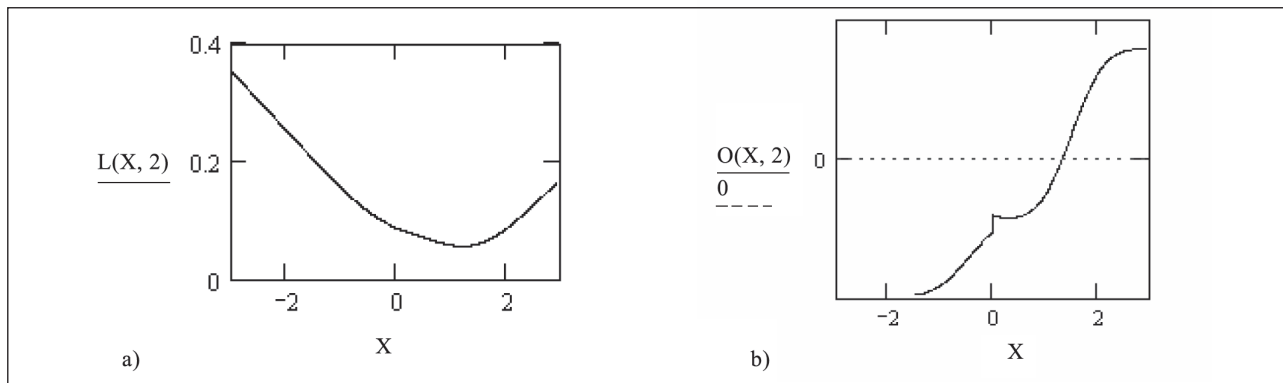


Fig 12. The dependence of: a) the average costs of settlements, and b) the gradient of the objective function on the sum of deposit

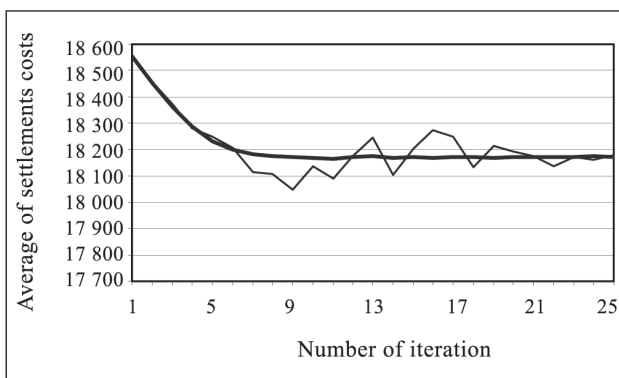


Fig 13. Dependence of the average settlement costs of the first participant on the number of iteration

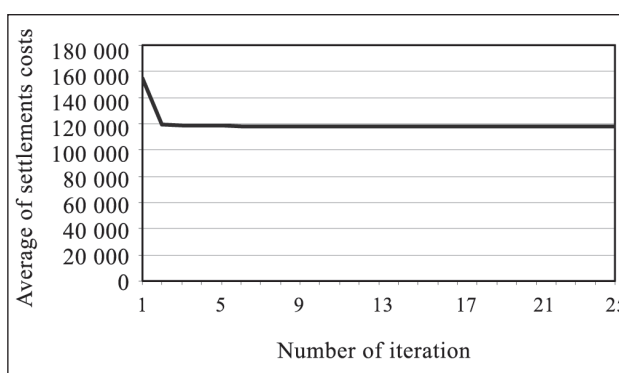


Fig 14. Dependence of the average settlements costs of the 9<sup>th</sup> participant on the number of iteration



Fig 15. Dependence of the average settlements costs of the 10<sup>th</sup> participant on the number of iteration

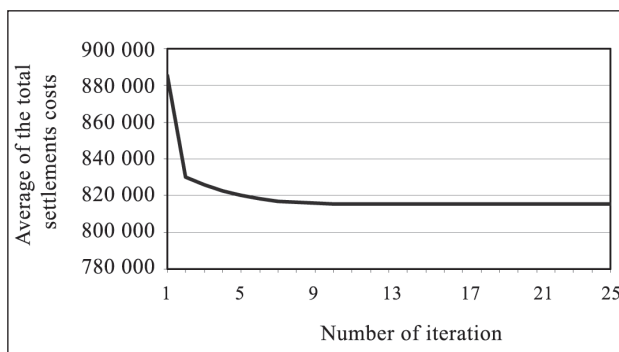


Fig 16. Dependence of the average total settlements costs on the number of iteration

## 7. Management of interbank settlement systems

Let us consider the management policy of the interbank settlement system by a clearing house. Note that the average income of a settlement institution (clearing house)  $BP$  can be computed as follows:

$$BP(X, RR) = \sum_{i=0}^J (L_i(X_i, RR_i) - TT_i). \quad (9)$$

Policy of management of participants of the system is formulated as a framework of game theory, where all the agents of a settlement system aspire to minimise their processing costs  $L_i(X_i, RR_i)$  by choosing deposit or withdrawal sums  $X_i$ , and a settlement institution minimises incomes  $BP$  by choosing the reserve requirements  $RR = (RR_1, RR_2, \dots, RR_J)$  under the condition that the frequency of liquidity loss  $P_{likv}$  is not higher than the set volume  $\alpha$ . Let us consider the case, when participants of the system manage their correspondent accounts by minimising the settlement costs (8) and do not form coalitions. Then the task of stochastic optimisation with a restriction on the frequency of the loss of liquidity can be formulated as follows:

$$BP(X, RR) = \sum_{i=0}^J (L_i(X_i, RR_i) - TT_i) \rightarrow \min_{RR} \quad (10)$$

$$L_i(X_i^*, RR_i) = \min_{X_i} L_i(X_i, RR_i), \quad (11)$$

$$P_{likv}(X^*, RR) \leq \alpha. \quad (12)$$

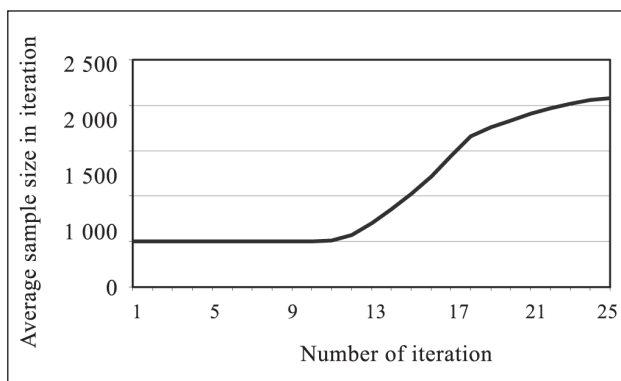
## 8. The results of simulation and optimisation

In this section, we present some Monte-Carlo simulation results, which were calculated using the proposed model, calibrated with respect to real data. The parameters of the Poisson-lognormal model were taken from [32]. The objective function (8) is minimised using stochastic non-linear optimisation approach by Monte-Carlo estimators (see details in [32, 34, 35]). Figs 13–15 illustrate the dependencies of the average settlement costs on the number of iteration for the 1<sup>st</sup>, 9<sup>th</sup> and 10<sup>th</sup> participants. Analogous dependencies are similar for other agents. In Fig 16, the dependence of the average total settlements costs on the number of iteration is presented. Fig 17 shows dynamics of the Monte-Carlo sample size during the optimisation. In Fig 18, we give a histogram of the iteration numbers for algorithm termination.

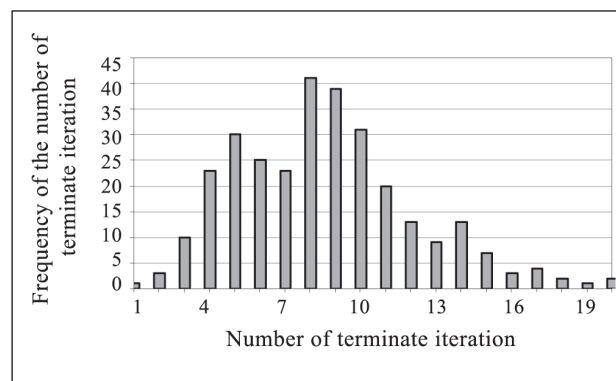
## 9. Conclusions

The growth of non-cash payments and the need to execute real-time payments invoke new challenges to electronic systems in the interbank clearing.





**Fig 17.** Dependence of the average sample size on the number of iteration



**Fig 18.** Histogram of the iterations numbers for algorithm termination

The basic principle of simulation systems is that the given payment flows are processed in a given model of the existing or contemplated payment and settlement system structure. It allows simulating different systems of interbank settlements and their processing. The simulators support RTGS, CNS, and DNS systems. The processing options for these systems are defined by selecting appropriate algorithms. The usable algorithms simulating the interbank settlement allow us to simulate the processing system of settlements by computer following the settlement instructions of a Central Bank and estimating the efficiency of management policy of the interbank settlement system by a clearing house. The main output factors in simulations are typically counterparty risk and overall risk, liquidity consumption, settlement volumes, gridlock situations and queuing time. The usable procedures allow managing the transactions queue, identifying and solving the gridlock situations.

The outcome of the performed simulation shows that, applying the given model of the income of a Clearinghouse as well as information technologies, it is possible to optimise the parameters for risks of credit,

liquidity, and operational costs management. Simulation and optimisation of the transaction costs illustrate an opportunity for banks to maximise the future profit.

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## TARPBANKINIŲ ATSISKAITYMŲ IMITACINIO MODELIAVIMO SISTEMA

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Santrauka

Sparčiai besivystančios informacinės technologijos stipriai veikia kitas ūkio šakas bei jų veiklą. Informacinių technologijų plėtra teikia galimybę diegti rinkoje naujus produktus ir plėtoti jų taikymą. Paskutiniai praėjusio amžiaus dešimtmečiai pasižymėjo informacinių technologijų intervencija į finansų rinkas. Finansų ir kredito institucijos, pastebėjusios naujas konkurencines galimybes, savo klientams visame pasaulyje itin gausiai pradėjo siūlyti tarpinstitucinių atsiskaitymų priemonės, valdomas informacinėmis technologijomis. Tarpbankinių mokėjimų plėtra, augantis poreikis mokėti realiojo laiko režimu kelia papildomų reikalavimų tarpbankinių atsiskaitymų sistemų technologijoms. Aktyvus elektroninių informacijos perdavimo priemonių diegimas į bankininkystę ir didelės atsiskaitymų dalies telkimas tam tikruose bankų sistemos centruose leido sukurti automatizuotus atsiskaitymo centrus – tarpbankinių lėšų pervedimo ir priešpriešinių mokėjimų padengimo sistemos. Tarpbankiniai atsiskaitymai per centralizuotas atsiskaitymų sistemas naikina būtinybę turėti korespondentinių sąskaitų visuose bankuose, per kuriuos atliekami tarpbankiniai atsiskaitymai, arba turėti tų bankų korespondentines sąskaitas savo banke. Pagrindinis automatizuotos atsiskaitymų sistemos projektavimo ir valdymo tikslas yra greita ir racionali mokėjimų apyvarta, subalansuojant mokestinius reikalavimus ir pavidimus, mažinant riziką bei pinigų masės judėjimą. Naujų automatizuotų atsiskaitymo sistemų technologijų kūrimas, jų vystymosi ir plitimo perspektyvos bei tempai, jų įtaka makroekonomikai daro nagrinėjamą temą aktualią tiek teoriškai, tiek praktiškai.

**Reikšminiai žodžiai:** bankiniai mokėjimai, atsiskaitymų sistemos, bankinių atsiskaitymų imitacinis modeliavimas.

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